FROM SCAVENGING TO QUARRYING: MASSIVE GLASS-RICH DEPOSIT UNVEILED AT SCHRODINGER CRATER AND ITS POTENTIAL FOR RESOURCE UTILIZATION. M. Prakash[1,2,3], C. Grima[2,3], S. P. S. Gulick[1,2,3], M. T. K. Jordan[1,2,3], G. Y. Kramer[4], [1]Department of Earth and Planetary Sciences, Jackson School of Geosciences, University of Texas at Austin (medhaprakash@utexas.edu), [2]Institute for Geophysics, Jackson School of Geosciences, University of Texas at Austin, [3]Center for Planetary Systems Habitability, University of Texas at Austin, [4]Planetary Sciences Institute.

Introduction: The sustainable expansion of human presence on the Moon depends on shifting from Earth-reliance to In-Situ Resource Utilization (ISRU). Historically, lunar resource models have focused on extracting trace constituents from unconsolidated regolith, such as polar water-ice or ilmenite ($FeTiO_3$). However, these disseminated resources often require extensive processing to yield mission-sufficient volumes of oxygen or metals. A more efficient paradigm involves the identification of bulk cohesive ore bodies, which would allow for high-volume extraction with reduced processing overhead.

Our investigation focuses on the Schrödinger Basin, a peak-ring basin bordering the South Pole-Aitken (SPA) domain that preserves a complex record of impact and volcanic processes [1]. We have identified a massive 10^4 km^3 geological unit exposed across multiple structural features, including the peak ring and an extensive network of cliff-forming grabens. The texture, stratigraphy and geologic context of this unit are akin to those of terrestrial melt-bearing impact breccias (e.g., suevite) [2]. These exposures provide a unique window into the basin's sub-surface stratigraphy, revealing thick, cohesive layers rather than the thin surface veneers typical of mare regolith.

Drawing a compositional analogy to terrestrial suevites (e.g., the Ries or Chicxulub craters), we hypothesize that these deposits represent a primary, high-density source of amorphous silicates and metal oxides. Terrestrial analogs suggest that such impact-melt breccias can host significant volumes of glass (30% to 50% by volume) where iron and other cations are held in a disordered matrix rather than a crystalline lattice [3].

Context: The 3.8 Gy old Schrödinger basin is one of the best-preserved impact basins of its size (320 km) on the Moon [1]. Schrödinger Basin allows us to study over 3 billion years of lunar history, perhaps having formed within ring structures of the earlier South Pole-Aitken (SPA) impact overlain by kilometers of SPA ejecta [4]. The impact basin has a peak ring composed of deep crustal material, and Imbrian to Eratosthenian volcanism is preserved as mare and pyroclastic deposits in the crater basin [4,5]. However, the subsurface stratigraphy of the basin is not well constrained.

Observation: We used high resolution imagery from Lunar Reconnaissance Orbiter (LRO) cameras, topographic data from Lunar Orbiter Laser Altimeter (LOLA) and M^3 VNIR Reflectance. We identified and cataloged outcrops of interest with three photometric and morphological criteria: 1) albedo

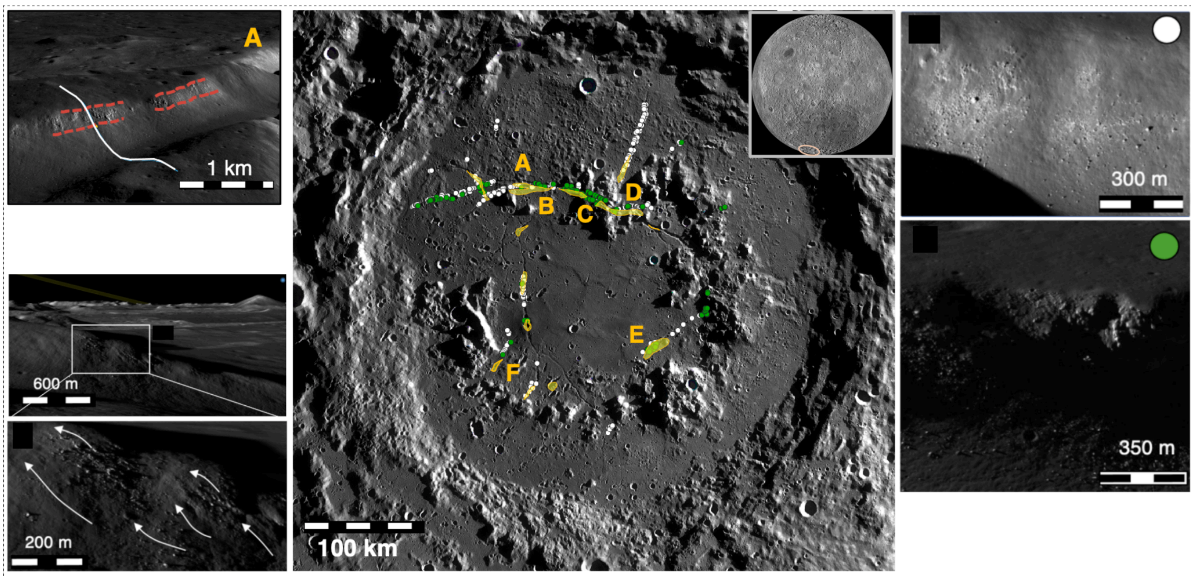

Figure 1. Mapped outcrops throughout Schrodinger basin. **(Left up)** Typical blocky cohesive outcrop. **(Left middle-bottom)** deposit climbing up topography in peak ring with onlapping geometry. **(Right)** Examples of two identified textures: finer grained, diffuse material with trailing boulder falls in a central basin graben (green dots) and cohesive-rubbly texture in the shadowed side of a concentric graben with extensive boulder falls (white dots).

contrast, 2) steep slopes, and 3) apparent material heterogeneity. The apparent thickness of the exposed layer is heterogeneous across the basin. The layer closely follows the surface topography, being found at elevations of ~-4100 m to -4800 m in the basin, consistently 10-20 m beneath the surface. The identified layer is characterized by three distinct signatures: 1) a high albedo layer that appears to crop out within graben walls and parts of the peak ring, 2) two textures observed: rubbly/blocky facies with many boulders > 0.5 m in diameter, and boulder trails dominated by boulders and finer material. 3) The slope of the high albedo, distinctly textured layer is up to 48 degrees demonstrating it is a cliff forming unit exhibiting steeper slopes than units above and below. Well-exposed outcrops of the mapped layer are high albedo and spectrally heterogeneous, showcasing crystalline and glassy pyroxene, olivine, and anorthositic lithologies. Within the layer we observed a series of dipping planes that thin upslope forming an onlapping geometry.

Intepretation: We suggest that this layer is consistent with a 138-m thick melt-bearing impact breccia (suevite) extending through the whole basin that formed during the Schrödinger impact. Hydrocode modeling of the Schrödinger impact implies that rocks which experience shock-pressures necessary to produce impact melt (>60 GPa) would be concentrated in the central basin forming a melt sheet, whereas the mapped melt-rich layer deposit is found capping the peak ring crystalline rocks, within the annular trough, and in the central basin and varying elevations. This pattern of deposition indicates some movement needed for emplacement [6]. The onlapping geometry of the layer within the peak ring region suggests a lateral flow mechanism which is consistent with a ground-hugging flow. Such a mechanism could explain the deposition of this material throughout the basin allowing for the unit's presence inside and outside the topographic peak ring. The observation of a rubbly texture and presence of boulder falls beneath the cliff forming layer is consistent with a heterogenous material, such as a breccia, as opposed to columnar jointing expected in volcanic flows or melt sheets. Analogy to terrestrial type-localities suggests that the cliff-forming units at Schrödinger may represent a high-grade industrial feedstock. In well-characterized terrestrial analogs such as the Ries Crater, suevite deposits are documented to contain 30% to 50% glass by volume [7].

In-Situ Resource Potential: The detection of cliff-forming, cohesive units in the Schrödinger grabens suggests a paradigm shift from regolith-scavenging toward a scalable quarrying architecture. Terrestrial suevites from the Ries and Rochechouart craters have historically served as competent building stones [8,9]; similar lunar deposits could provide structural blocks for habitat shielding, significantly reducing the mechanical wear and dust mitigation issues associated with processing abrasive, unconsolidated regolith. Furthermore, the exposure of these units within the graben network suggests that autonomous robotic quarrying could target vertical cliff faces, utilizing the natural fracture patterns of the grabens to minimize excavation energy and bypass the high-mass sorting equipment required for standard regolith ISRU.

As a high-density feedstock, the amorphous state of the Schrödinger suevite offers distinct chemical and structural advantages over crystalline minerals. The disordered matrix of impact-melt glass holds iron and other cations in a frustrated state, which lowers the activation energy required for hydrogen reduction or molten regolith electrolysis compared to rigid crystalline lattices like ilmenite [10,11]. Beyond oxygen production, this anhydrous lunar glass can be processed into high-strength continuous fibers and ceramics [12,13] or utilized as a primary reinforcement phase in "Mooncrete" for hardened infrastructure [14]. By identifying a bulk cohesive ore rather than dispersed traces, the Schrödinger Basin presents a unique opportunity to utilize a single, concentrated geological unit for both chemical consumables and structural manufacturing.

Future Characterization: Investigations should prioritize the quantification of the glass-to-clast ratio and the chemical homogeneity of the amorphous matrix. Landed *in-situ* measurements, such as Micro-XRF or Raman spectroscopy, could assess the distribution of minerals in the impact-melt glass and provide estimates of its mechanical properties to help design autonomous cutting or thermal-spalling technologies.

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